Review Article

Extracoronal direct retainers for distal extension removable partial dentures

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Distal-extension removable partial dentures have always posed a challenging situation to the clinician and in such cases the strategic positioning of the direct retainers would ensure the long-term success of the prosthesis. Different direct retainer designs have been discussed by various authors in the literature. This paper highlights the extracoronal direct retainers, which can be used in the successful prosthodontic rehabilitation of distally edentulous arches with a removable partial denture.

Key words: clasps in distal-extension RPDs; direct retainers; distal-extension removable partial dentures.

The selection of direct retainers for distal extension removable partial dentures has stimulated general discussion, numerous articles, and considerable interest among dentists for many years. Attempts at improving the design of the prosthesis to protect the abutment teeth have been a concern for dentists. These attempts can be successful only when the different forces acting in distal extension removable partial dentures and the various clasp designs are clearly understood.

Forces acting on distal extension removable partial dentures and clasped distal abutment tooth

Three types of stresses are induced on the abutment teeth by a distal-extension removable partial denture. Vertical stress results from a lack of distal tooth support, horizontal stress results from a lateral movement of the denture, and oblique stress results from a combination of vertical and lateral forces. In all types of stress the abutment becomes a fulcrum.[1]

In a *symmetrical bilateral* distal extension removable partial denture, the long axis of the denture base is perpendicular to the axis of rotation. Occlusal forces tend to move the denture base in an arc almost parallel to the longitudinal axis of the residual ridge and towards it.[2]

In the *asymmetric bilateral* distal extension removable partial denture, the axis of rotation is not perpendicular to the ridge. The resultant vector of force is directed in a buccal to lingual direction on the longer edentulous side and from a lingual to buccal direction on the shorter edentulous side as the framework rotates eccentrically.[2]

A *unilateral* distal extension removable partial denture is an extreme situation where the axis of rotation is at an angle to the long axis of the ridge instead of parallel to it.[2]

In the *distal-extension RPD*, functional forces applied to the denture base create an axis of rotation around the most distal abutment teeth. When the clasp tip is placed mesial to the axis of rotation, the effect of torque on the clasped teeth can be compared to the action of a class-I lever. Both the degree and direction of this movement are greatly influenced by the quality of the supporting residual ridge, the design of the RPD, and the extent of the forces exerted on the denture during function.[3]

When the clasp tip is placed distal to the axis of rotation, it creates the desired class-II lever effect, allowing rotation of the RPD base towards the tissues without torquing the clasped tooth. The axis of rotation is designed around the mesial rest, far from the distal extension, and the retentive arm is designed to be nearer to the distal extension. Occlusal forces cause the distal base and the retentive arm to move towards the tissue around the mesially designed axis of rotation, thus resulting in a stress releasing effect (class-II lever effect).[3]

Essentials of design

The simplest type of clasp that will accomplish the

Presented at the 32nd conference of the Indian Prosthodontic Society held at Bangkok in December 2004.

design objective should be employed. The clasp should have good stabilizing qualities, remain passive until activated by functional stress, and accommodate a minor amount of movement of the base without transmitting a torque to the abutment tooth. Clasps should be strategically positioned in the arch to achieve the greatest possible control of stress.[4]

A *Kennedy's class-I* prosthesis usually requires only two retentive clasp arms: one on each terminal tooth.

1. If a distobuccal undercut is present, then the vertical projection retentive clasp is preferred.
2. If a mesiobuccal undercut is present, then a wrought wire clasp is indicated. A cast circumferential type clasp should not be used.
3. The reciprocal or bracing arm must be rigid. This component of the clasp system can be replaced by lingual plating.[4]

A Kennedy's class-II prosthesis should usually have three retentive clasp arms. The distal extension side should be designed with the same consideration as for class-I prosthesis. The tooth supported or modification side should usually have two retentive clasp arms: one as far posterior and one as far anterior as tooth contours and esthetics permit. If a modification space is present, it is usually most convenient to clasp a tooth anterior and a tooth posterior to the edentulous space.[4]

The retentive portions of the clasps are placed in undercuts relative to the path of insertion and withdrawal of the denture. When the fulcrum line is transferred to the upper margin of the lingual plate the clasps will tend to resist occlusal and distal movement. Occlusally approaching clasps should be designed with the entire clasp as low as possible on the tooth consistent with gingival health to gain maximum mechanical advantage while reducing visibility of the clasp. If possible, the shape of the tooth should be modified by grinding or by addition of composite resin to place the survey line low on the tooth. Ideally the rigid part of the clasp should be positioned on the survey line to minimize leverage forces under occlusal load. Gingivally approaching clasps may be better esthetically and place fewer leverage forces on the abutment teeth. However, their greater flexibility may necessitate the addition of mesial and distal grips to resist distal movement of the denture.

Research using photoelastic analysis of various clasp designs arrived at the following conclusions:[3]

1. The design of a retainer with mesial rest in conjunction with a buccal I-bar exhibited the most favourable distribution of vertically applied forces.
2. Retainer designs with a distal rest tend to move the clinical crown distally and the root mesially at the apex, resulting in horizontal forces in the bone.
3. Placing rests of distal extension removable partial dentures more anteriorly provides an axis of rotation that directs applied forces in a more vertical direction.
4. The distal rest in conjunction with circumferential retainers developed greater horizontal forces within the supporting structures.

Clasp assemblies advocated for distal-extension removable partial dentures

RPI clasp design

Kratochvil developed an innovative clasp assembly in the early 1960s. It consists of three separate units connected to each other only through the framework. They are (1) an occlusal rest arising from a minor connector on the side of the abutment away from the edentulous space, (2) an I-shaped bar clasp retaining arm placed mid-buccally on the abutment and (3) a vertical plate contacting the distal and distolingual surfaces of the abutment adjacent to the edentulous space. In devising this clasp assembly, he incorporated the idea of a remote rather than an adjacent rest, adopted and relocated the I-bar retainer and originated the proximal plate.[5]

This clasp configuration was designed for the specific purpose of allowing extension-base removable partial dentures some degree of tissue ward rotational freedom without torque to the clasped tooth. Krol made certain modifications in the design of the proximal plate and supplied a name – the RPI-bar clasp design.[5] It is the most accepted stress-releasing clasp design described in the literature.[3]

This clasp assembly permits the design objective of a small degree of tissue ward rotation of the distal-extension base if the following specific requirements are fulfiled:[5]

1. The minor connector on the mesial is not against the adjacent tooth and has room to move.
2. The I-bar is positioned on or anterior to the midline for symmetrical Kennedy's class-I partial denture or distal to the axis of rotation in asymmetric distal extension partial dentures.[3]
3. The proximal plate does not bear above the height of contour or it is physiologically freed.
4. The distal surface of the abutment does not have a mesial inclination in reference to the occlusal plane.

Advantages[5],[6]

- Minimal use of spring tension in the retentive arm,
- beneficial effect on the periodontium of less change in tooth contour,
- practically no increase in the size of the occlusal table,
- maximum exposure of the gingival tissue,
- good resistance to occlusal displacement,
- shows less metal than other clasps,
- avoids contact with the lingual surface of the

abutment tooth, and

- without a lingual arm, the high survey line on the lingual surface of many mandibular teeth is not a problem.

Contraindications[6]

- Insufficient vestibular depth,
- undercut located close to the gingival margin,
- tissue undercut below the abutment teeth, and
- difficult to manipulate, especially for patients with arthritis or other physical disabilities as there is no convenient component to grasp with finger or thumbnail for its removal.

RPL clasp design

The effectiveness of the RPI clasp assembly can be increased if the I-bar is replaced by an L-shaped bar direct retainer. The retainer has been described as one-half T-bar or a modified T-bar clasp or R-bar clasp.[7],[8] The mesio-occlusal rest and proximal plate are designed as in the RPI clasp assembly. However, the I-bar is replaced by an L-shaped direct retainer arising from the framework distobuccal to the abutment tooth. The L-bar crosses the gingival margin of the abutment tooth in the shortest possible line, ascends to the survey line, and engages the distobuccal undercut.[7]

The L-bar when placed near or at the same horizontal level as the occlusal rest, frees itself from the abutment tooth when rotation if the denture occurs around the mesio-occlusal rest. Because it is located more distally on the buccal surface, the L-bar is more esthetically acceptable. The absence of undercuts on the buccal surface of a mandibular premolar or canine necessitates tooth recontouring if an I-bar is used. This recontouring may have to be extended anteriorly to provide freedom for disengagement of the I-bar as the extension base moves towards the tissue. A disto-buccal undercut is invariably present for use of an L-bar. A distal path of insertion may be used without stressing the abutment tooth. The L-bar is easier to grasp, facilitating removal of the prosthesis.[7] One author recommends avoiding use of this clasp on the distofacial surface of canine abutments.[8] From a theoretical standpoint, this clasp may be unable to disengage from the tooth as the distal-extension base moves towards the tissue. The clasp arm would bind against the tooth and create a mesially directed force on the tooth. However, the clasp arm is quite flexible because of its length, and no ill effects from binding have been noted clinically. The L-bar clasp arm is less likely than the I-bar clasp arm to result in insufficient retention in the completed framework caused by incorrect waxing or finishing techniques because of more tooth contact.[9]

RPA clasp design

The RPA clasp (rest, proximal plate and Akers clasp) was developed at the University of the Pacific School of Dentistry to overcome some of the problems encountered with the RPI clasp. The mesial rest and proximal plate are designed identically to those of the RPI clasp. The difference is in the retentive arm. An Akers, or circumferential clasp arm, arises from the superior portion of the proximal plate and extends around the tooth to engage the mesial undercut.[6]

In the survey of an abutment tooth for the RPA clasp, a fairly normal tooth alignment is needed with a survey line in approximately the middle of the tooth, providing undercuts on both the mesial and distal aspects of the facial surface. There must be at least a 0.01 in. undercut mesially. The superior border of the retentive arm is placed on the survey line from the proximal plate to the middle of the tooth; where it then drops down to engage the necessary undercut for proper retention. The undercut will vary from 0.01 to 0.02 in., depending on the size of the tooth and the length of the retentive arm. The rigid portion of the clasp arm will contact the tooth only along its superior border at the level of the survey line. When an occlusal load is applied to the denture base, the retentive arm can move into the undercut because of the relief under its rigid section and release from the abutment tooth.[6]

Advantages[6]

- Easier to grasp for removal of the prosthesis,
- simple design with few variations and thus can be easily and consistently fabricated by dental laboratories, and
- the circumferential retentive arm avoids the tissue problems around abutment teeth.

However, the RPA clasp design is not suited to asymmetric bilateral distal extension removable partial dentures, especially on the shorter edentulous side.[3]

Equipoise back-action clasp

In addition to the RPI, RPL and RPA clasp assemblies, back-action type Equipoise clasp assemblies have been suggested in the literature as stress releasing components in the design of distal extension removable partial dentures.[3]

Under most circumstances, the back-action clasp has been shown to cause less displacement and stress than the conventional clasp in all directions, except mesially. However, this mesial force, greatly reduced by the support from the adjacent tooth, is directed to the vertical axis where it becomes innocuous.[1]

Combination clasp design[9]

The combination clasp uses a wrought wire retentive arm. A wrought wire is preferred for retention when the undercut occurs in the mesial third of the buccal surface of an abutment tooth. The terminal third of the clasp arm lies gingival to the height of contour while the proximal two-third lies on the height of contour.

Advantages

- Adjustability,
- lack of tissue coverage and
- reparability.

Disadvantages

- Tthey may be poorly adapted by the dental technician,
- loss of adaptation of the wire after a period of time, which may be due to improper,
- placement of the wire,
- susceptibility to fracture. However, this problem can be controlled by improved and
- construction technique and careful selection of material.

Proper material selection is crucial in determining whether wires maintain their adaptation, whether breakage will be a problem, and whether flexibility will be adequate.

Gauge of wire used will depend on

- Abutment periodontal support,
- degree of reciprocation,
- clasp arm length,
- undercut depth and
- amount of retention desired.

Brudvick and Wormley measured the effect of solder joint location on clasp flexibility. More than 40% of the flexibility was lost if the framework was cast to the wire or if the wire was soldered on the distal guiding plate. Only a 6% decrease was noted if the wire was soldered farther back on the framework. Clinical observation of removable partial dentures with clasp solder joints placed in this location has revealed a dramatic reduction in the number of fractured clasp arms and an increase in their flexibility.

Remodified Hart–Dunn attachment design[10]

Using the RPI assembly on the edentulous side and the remodified subpontic attachment in conjunction with the modified pontic design on the dentulous side of the arch reduces forces to the abutment teeth as measured by Kratochvil and Caputo. This remodified attachment system minimizes the deleterious rotational effect of the anterior or posterior parts of the removable partial denture.

The undersurface of the pontic should be convex from buccal to lingual and concave from mesial to distal to allow free movement of the 18 gauge wrought wire that contacts it along the axis of rotation. It also offers resistance to dislodgement in an occlusal direction. Lingual plating is used to improve the bracing effect of the partial denture framework. This bracing assists in reducing lateral movement of the prosthesis around a vertical axis. Place the occlusal rest directly over the subpontic clasp and contour the clasp for free and easy insertion and removal of the prosthesis by the patient. The isthmus distance between the wrought wire attachment clasp on the tissue side of the pontic and the tooth side of the occlusal rest dictates the amount of rotational angulation that is necessary. Patients with a restricted mandibular opening require an especially narrow pontic isthmus from the clasp to the occlusal rest. This width allows the remodified attachment to be nearly straight as it passes beneath the modified pontic. The attachment wire should be approximately 2 mm longer on the labial aspect then on the lingual aspect. This extra length permits the dentist to contour the wire attachment during the fitting of the framework and the subsequent delivery of the prosthesis.

This remodified Hart–Dunn attachment prevents vertical displacement of the removable partial denture in an occlusal direction on the dentulous side of the arch. The occlusal rest system directly over the attachment prevents apical vertical displacement on that side of the arch. The guide planes, minor connectors, occlusal rests, and plated lingual contours brace the partial denture. Minimal retention design and placement of a subpontic attachment along or close to the horizontal axis of rotation reduce the torquing forces on abutment teeth. This new clasping and embrasure-like subpontic attachment system combination is physiologically compatible with the remaining hard and soft tissues of the restored dental arch. Minimal retention, reduced torque throughout the arch during function, and distribution of force according to sound mechanical principles make this remodified subpontic attachment the preferred method of treating most unilateral distal extension removable partial denture patients.

Esthetic retainers for maxillary canine

Esthetic clasp placement on a canine abutment tooth is a challenge in designing a maxillary bilateral distal extension removable partial denture. Two esthetically viable options are discussed here.

Mesial groove reciprocation (MGR) clasp:[11] McCartney described the MGR clasp in an effort to use the distofacial surface of the maxillary canines for retention and esthetic advantage. This clasp design used a mesiolingual reciprocating groove and rest seat to achieve bracing against distal movement. Retention was provided by a distofacial dimple into which a wrought wire I-bar was adapted.

Distofacial ridge modification

The distofacial ridge is used in conjunction with a cast I-bar arm that is placed just anterior to the distofacial

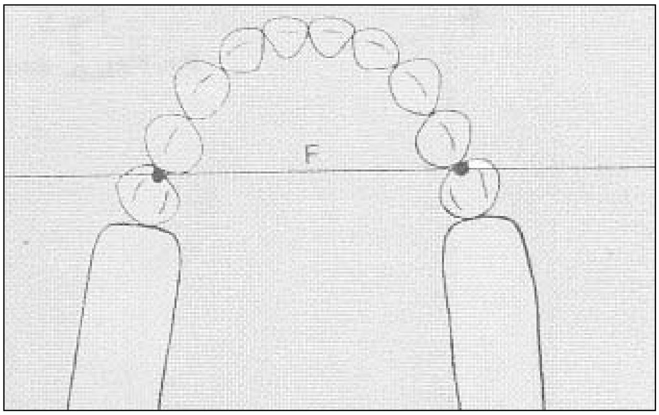

Figure 1: Axis of rotation in a symmetrical distal-extension RPD

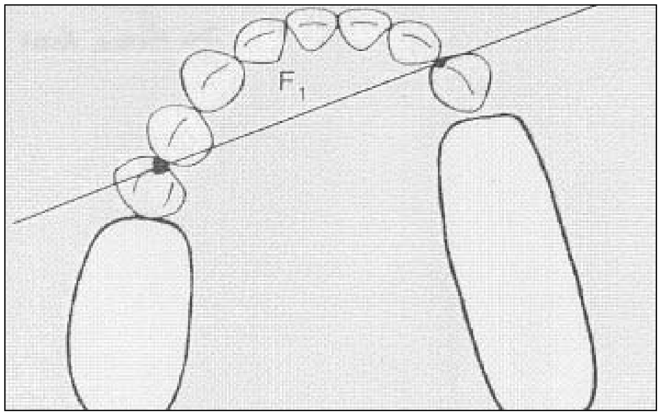

Figure 2: Axis of rotation in an asymmetric distal-extension RPD

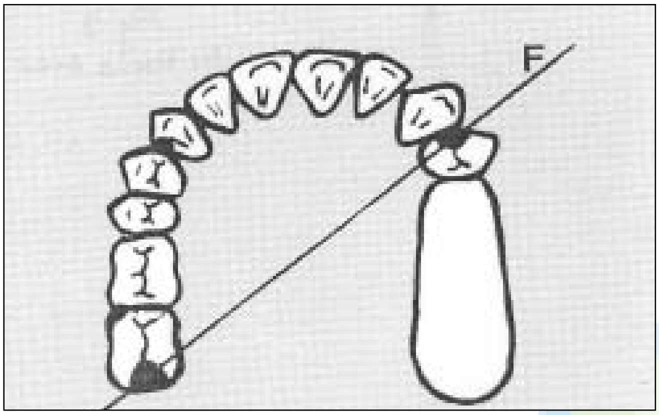

Figure 3: Axis of rotation in a unilateral distal-extension RPD

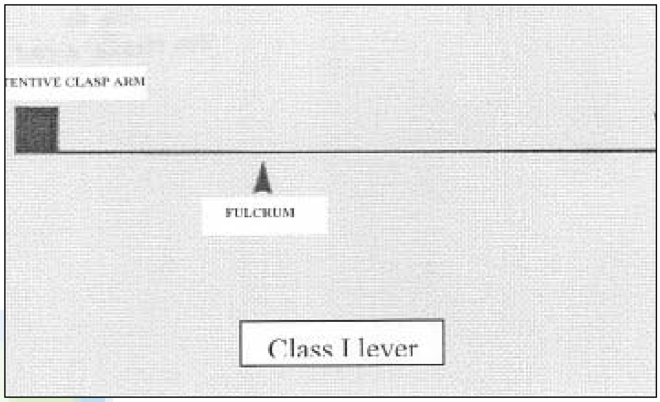

Figure 4: Class-I lever

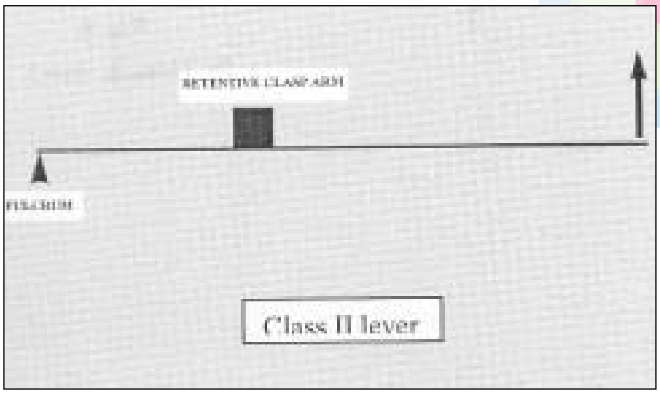

Figure 5: Class-II lever

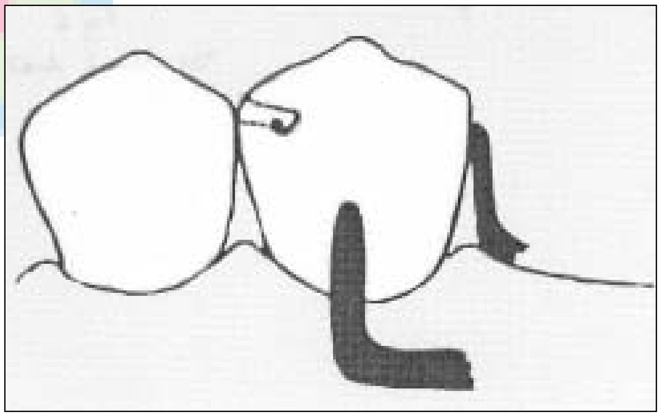

Figure 6: RPI clasp

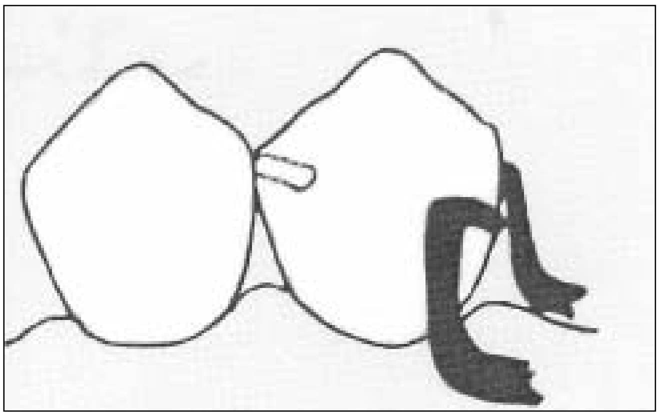

Figure 7: RPL clasp

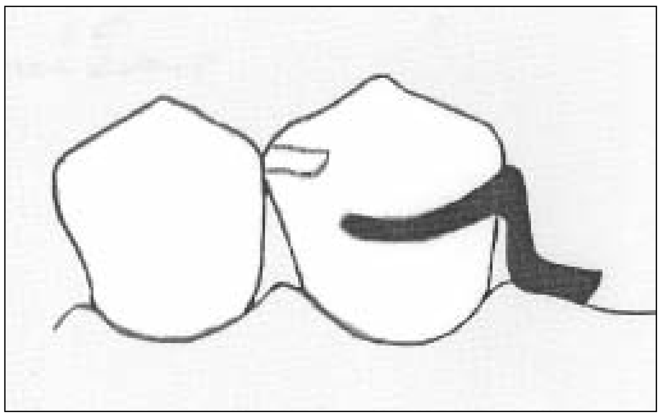

Figure 8: RPA clasp

CMYK68

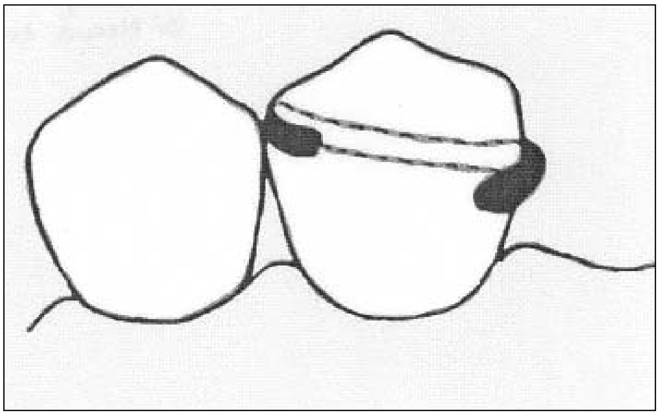

Figure 9: Equipoise back-action clasp

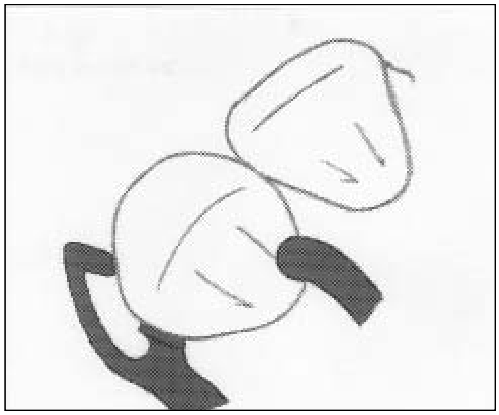

Figure 12: MGR clasp

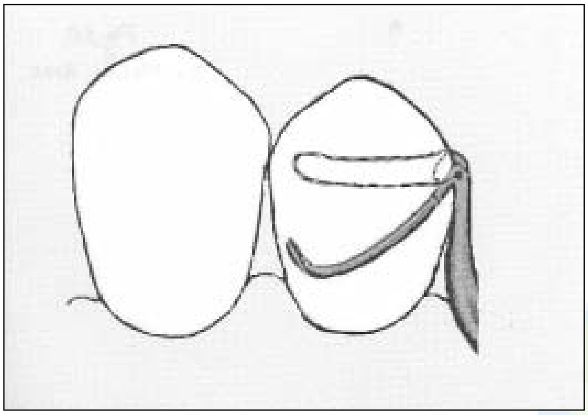

Figure 10: Combination clasp

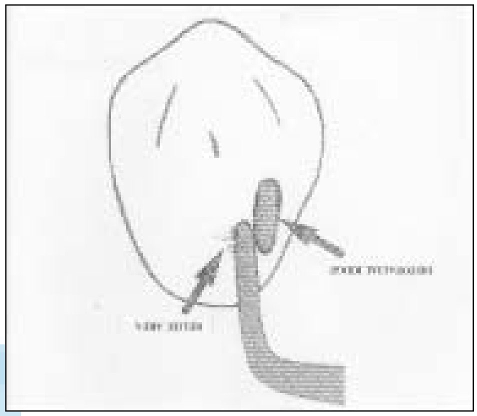

Figure 13: Distofacial ridge modification

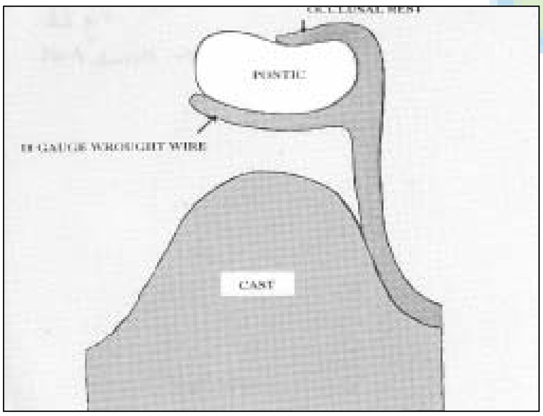

Figure 11: Remodified Hart–Dunn attachment

ridge and uses a 0.01 in. undercut for retention. The distofacial ridge prevents the prosthesis from moving distally during function and thus ensures that the direct retainer will remain engaged in the distofacial undercut. Immediately mesiogingival to the retentive tip of the arm, a small relief region is provided. The retentive arm tip can translate into this region during function and avoid engaging the tooth.

To reduce the degree of translatory movement of the retentive arms, the lingual rest seats should be located on an imaginary line drawn through the retentive tips of both canine clasp arms whenever possible. The accentuated distofacial ridge provides a more precise path of insertion and withdrawal for the prosthesis because the clasp arm is guided along the length of the anterior portion of the ridge.

The ridge may be placed on the distofacial surface of the canine as part of a pin-modified metal inlay, built into the design of a ceramometal restoration, or created with composite after etching the underlying enamel surface.

CONCLUSION

Direct retainers for distal extension removable partial dentures should be chosen after careful evaluation of each individual situation and consideration of the merits and contraindications of each clasp design. Once the retainer is chosen, meticulous adherence to proper designing principles will ensure a successful distal extension removable partial denture.

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